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NLP150L
Single and Triple
Application Note 124

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ARTESYN® TECHNOLOGIES

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- **90 to 264VAC universal input range**
- **Provides low voltage outputs (3.3V)**
- **Overvoltage and short circuit protection**
- **Power fail detection**
- **Current sharing (on V_A and V_B)**
- **3.8 x 6.8 x 1.26 inches**
- **Meets all applicable and relevant immunity standards**

1. Introduction

The NLP150L Single and Triple power supplies are high-frequency, low-cost, high-density, high-performance off-line AC to DC power supplies designed to operate with universal line inputs (90VAC to 264VAC) at a rated continuous output power of up to 110W with natural convection cooling and 150W with forced air cooling. The power supplies meet all major safety standards (UL, CSA and VDE) and are CE marked to LVD directives. They comply with the EMC directives (EN61000-4-2, 3, 4, 5), meet input harmonic current limits standards EN61000-3-2, as well as FCC/CISPR 22 (EN55022) Class B conducted EMI limits and Class A radiated EMI limits. The NLP150L Single and Triple output power supplies have a footprint of 3.8 x 6.8 inches with a maximum component height of 1.26 inches for use in a 1U application.

The NLP150L Single and Triple power supplies are intended for use in communication applications.

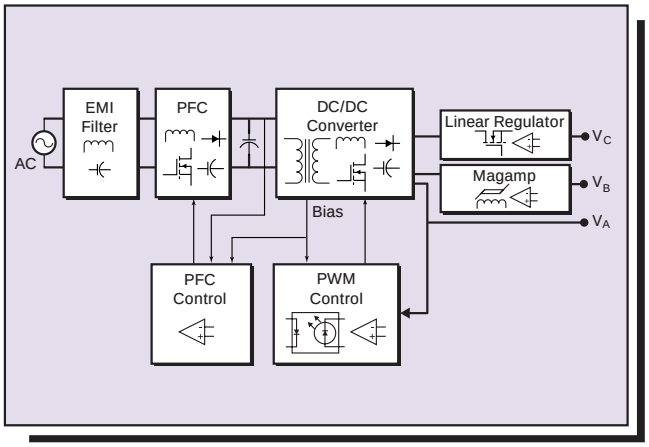

Figure 1 - Electrical Block Diagram

2. Output Voltages

The output voltages are listed in Table 1.

Model Number	Output Voltages
NLP150L-96S3	3.3V
NLP150L-96S5	5.1V
NLP150L-96S6	12V
NLP150L-96S8	24V
NLP150L-96S9	48V
NLP150L-96T536	5.1V, 3.3V, 12V
NLP150L-96T658	+12V, +5.1V, +24V

Table 1 - Output Voltages

3. Description

Electrical Block Diagram

A block diagram of the NLPL150L Single and Triple power supply is shown in Figure 1. There is a designated harmonic current correction (HCC) stage to ensure the product meets EN61000-3-2 harmonic content requirements.

A DC/DC converter following the HCC stage is used to provide safety isolation and regulation. The main channel is controlled by duty cycle in the DC/DC converter. A Magamp using Metglas square loop core controls the second high current output. The third output is regulated with a linear regulator consisting of a Mosfet and a voltage feedback loop. The Mosfet in this channel works in linear region. Opto-couplers are used for the control isolation.

Mechanical Description

The NLP150L Single and Triple power supplies are of open-frame type measuring 3.8" (W) X 6.8" (L) X 1.26" (maximum component height). Figure 2 shows the mounting hole locations.

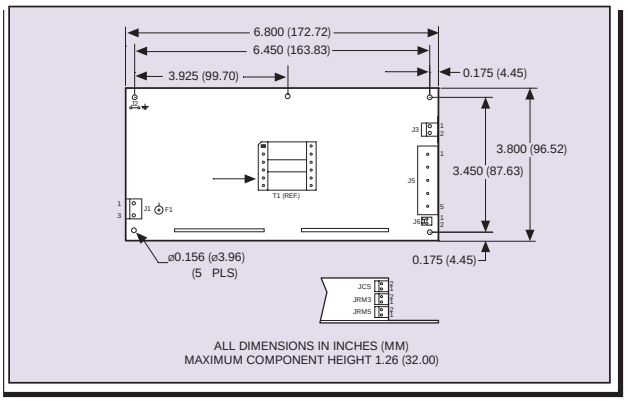

Figure 2 - Mechanical Drawing

Connector	Type	Mating Connector
J1	Molex 26-60-4030 or equivalent	Molex 09-50-3031 or equivalent with Molex 08-50-0105 or crimp terminals
J2	Male 0.250 quick disconnect	Molex AA-5261, AA-2201 or equivalent
J3	Molex 26-60-4040 or equivalent	Molex 09-50-3021 or equivalent with Molex 2478 phosphor bronze or equivalent crimp terminals
J5	Beau Interconnect 70-5-05-C-50 or equivalent	N/A
J6	Molex 22-23-2021 or equivalent	Molex 22-01-3027 and contact 08-50-0113 terminals or equivalent
JRM3 JRM5 JCS	Leoco 2421 P02H000 or equivalent	Leoco 2420S02000 and contact 2453TPB00V1

Table 2 - Connector and Mating Connector Types

Connector Pin Connections

J1 Is the input connector, a standard 3-pin Molex Spox type connector. The connector type and recommended mating connector and crimp terminals are listed in Table 2. The pin assignment is summarized in Table 3. The numbering is from right to left facing the open side of the connector.

J2 Is provided for safety earth connection for units used in applications where a metal chassis is not available. This connector mates with a Push-On Type terminal. See Table 2 for details.

J3 Is the ouput connector for V_C. Standard 2 pin Molex Spox type connectors with 0.156" spacing or equivalent are used for output. Mating connector recommendation is in Table 2. The pin assignment is summarized in Table 4. Pin numbering is from right to left facing the connector.

J5 Is the output connector for the two high current outputs V_A and V_B. Standard 5 circuit terminal block with 0.325" spacing (Beau Interconnect PN. 70-5-05-C-50) or equivalent are used. The pin assignment is summarized in Table 5. Pin numbering is from right to left facing the terminal block. No mating connector is needed for J5.

Pin No.	Function
1	Neutral
2	No Connection
3	Line

Table 3 - J1 Pin Connection

Pin No.	Function
1	V_C
2	V_C RTN

Table 4 - J3 Pin Connection

Pin No.	Function
1	V_A
2	V_A
3	RTN
4	RTN
5	V_B

Table 5 - J5 Pin Connection

J6 Is the connector for Power Fail Detection Standard 2 pin Molex 22-23-2021 type or equivalent is used. Pin assignment is summarized in Table 6. Pin numbering is from right to left facing the connector.

JRM3 and JRM5 On the secondary control board are for remote sensing of two high current output voltages V_A and V_B. Refer to Table 2 for connector types. Pin connections are listed in Tables 7 and 8. Pin numbering is from left to right facing the connector.

JCS On the secondary control board is for current sharing. Leoco 2421P02H000 type or equivalent connector is used for JCS. Pin assignment is summarized in Table 9.

Pin No.	Function
1	Signal
2	RTN

Table 6 - J6 Pin Connection

Pin No.	Function
1	V_B Sense +
2	V_B Sense -

Table 7 - JRM3 Pin Connection

Pin No.	Function
1	V_A Sense +
2	V_A Sense -

Table 8 - JRM5 Pin Connection

Pin No.	Function
1	V_A Current Sharing Bus
2	V_B Current Sharing Bus

Table 9 - JCS Pin Connection

4. Applications

Mounting

Referred to in Figure 2, four mounting positions are required. The power supplies also require a minimum mounting stand off of 0.25 inches. The mounting hardware for the mounting hole in the middle of the power supply maybe used for extensive vibration conditions. A plastic insert with one end snapped in the power supply and the other end screwed down or snapped in chassis should be sufficient.

Input Voltage

The NLP150L power supplies shall regulate their outputs within the specifications with an input voltage range from 90VAC to 264VAC and input frequency range from 47Hz and 63Hz. The units shall also pass input fast transients specified in EN61000-4-4 Level 3 severity and input surges specified in EN61000-4-5 Level 3 severity.

Input Current

The RMS input current shall be 1.95 Amps or less, at 120VAC input, 150 Watts output. Typical input currents at various line voltages are listed in Table 10.

Please note that the harmonic current correction circuitry ensures that the power supply meets EN61000-3-2 harmonic current requirements, but doesn't produce very high power factor across all the line and load combinations. The tendency is the lower the line and the heavier the load is, the higher the power factor is. Figure 3 shows typical power factor under 10%, 50% and 100% loading.

V_{in} AC (RMS)	Iin (AC) RMS	Pout
90V	2.55A	150W
120V	1.95A	150W
230V	1.10A	150W
264V	1.60A	150W

Table 10 - Input RMS Current

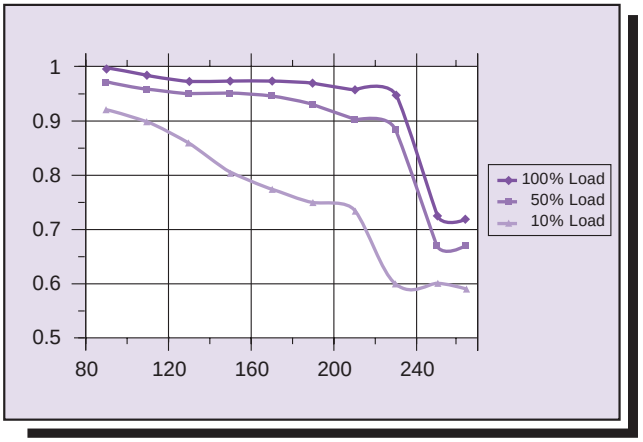

Figure 3 - Typical Power Factor

Input Start-up Surge (Inrush Current)
The peak cold start-up surge current for NLP150L power supplies at various line voltages shall be less than the values specified in Table 11.

V_{in} AC (RMS)	Iin (peak, cold start)	Line Impedance (Ohms)
90V	14A	0
120V	18A	0
230V	35A	0
264V	40A	0

Table 11 - Inrush Current

Load Types
The NLP150L power supplies can take both resistive load and constant current load.

Minimum Loading
To ensure proper output regulation of the power supply, the NLP150L product has specific minimum load requirements for different models. Table 12 summarizes the minimum loading requirements for NLP150L Single and Triple outputs. If a minimum load is not applied, the converter shall not be damaged but may not maintain specified performance.

In applications where minimum loading is not acceptable, dummy load can be used. Please consult factory for possible reduced minimum loading requirements when using dummy loads.

Model Number	Minimum Load					
	O/P1		O/P2		O/P3	
NLP150L-96S3	3.3V	1A				
NLP150L-96S5	5.1V	1A				
NLP150L-96S6	12V	0.3A				
NLP150L-96S8	24V	0.15A				
NLP150L-96S9	48V	0.1A				
NLP150L-96T536	5.1V	1.5A	3.3V	0.5A	12V	0A
NLP150L-96T658	12V	0.6A	5.1V	0.5A	+24V	0A

Table 12 - Minimum Load Requirements

Thermal
The maximum operating ambient temperature is 50ºC for full power. For operations above 50ºC (up to 70ºC), a 2.5% per degree C power derating should be used. The power supplies have different rating under natural and forced convection. Under natural convection, the maximum continuous output power is limited to 110W. Under forced air convection, the maximum output power is raised up to 150W with 300LFM.

The direction of the airflow has different cooling effects. As shown in Figure 4, the recommended airflow direction is blowing from the long side of the power supply. The best airflow direction is from the two control cards side. Airflow from the short sides is not output recommended because there will be components which can only get minimal air flow and suffer thermal stress.

The setup used for characterizing thermal performance and the effective airflow path are illustrated in Figure 5.

Table 13 summarizes the output loading of the NLP150L Single and Triple power supplies. The power supplies are designed to allow maximum loading flexibility in the first three output channels. In other words, any channel can deliver its full heavy current when loading in other channels reduce correspondingly.

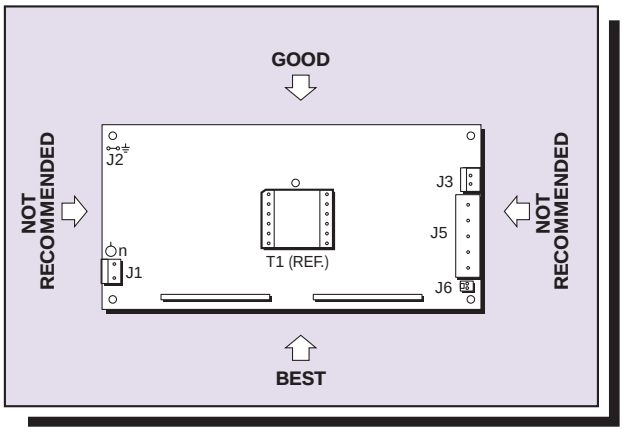

Figure 4 - Airflow Direction

Model	Convection Cooling			Forced Air 300LFM from recommended airflow direction		
	Vo (V)	Lo max (A)	Po max cont	Vo (V)	Lo max	Po max (A)
NLP150L-96S3	3.3	22	72.6W	3.3	30	99W
NLP150L-96S5	5.1	22	110W	5.1	30	153W
NLP150L-96S6	12	9.2	110W	12	12.5	150W
NLP150L-96S8	24	4.6	110.4W	24	6.5	150W
NLP150L-96S9	48	2.3	110.4W	48	3.2	153.6W
NLP150L-96T536	5.1	20	102W	5.1	30	153W
	3.3	10	33W	3.3	15	49.5W
	12	2	24W	12	3	36W
NLP150L-96T658	12	9.2	110W	12	12.5	150W
	5.1	6	30.6W	5.1	8	40.8W
	24	2	48W	24	3	72W

Table 13 - Output Current Ratings

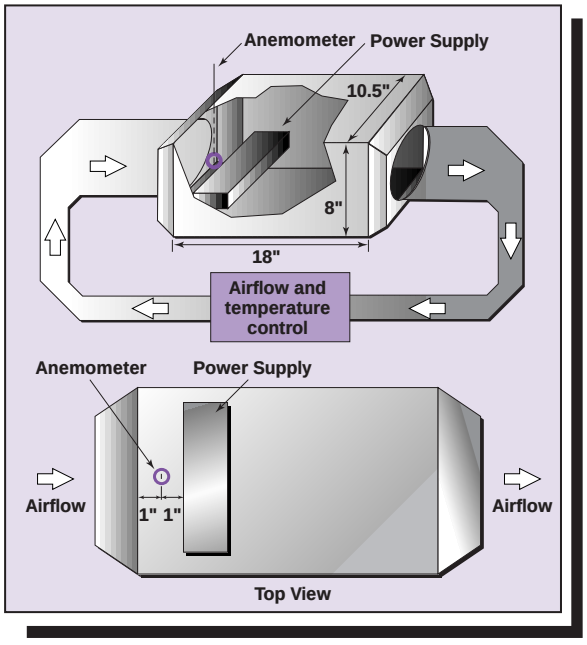

Figure 5 - Illustration of the Setup for Thermal Characterization

Overload Protection
The NLP150L power supplies, though have internal current/power limit mechanism, do not provide controlled over-load protection. The power supplies shut down the output when total output power reaches about 115% of rated full power. Overloading the converters for an extensive period of time may result in permanent damage to the power supplies. The power supplies, however, will fail in a safe manner (i.e. will not cause fire or electrical shock hazards).

Over-voltage Protection
The NLP150L power supplies provide over-voltage protection to both the first and the second outputs. The over-voltage protections are activated, when the output voltage reaches between 115% and 135% of the nominal value. Once the OVP is activated, the power supplies will shut down and remain off until restarted by cycling the input power.

Short-circuit Protection
The outputs shall protect themselves against short-circuit failure (defined as output impedance less than or equal to 0.1 Ohms) for an indefinite period of time by cyclic operation (hick-up).

Parallel Operation
The NLP150L power supplies are designed for current share of V_A and V_B only. One wire common bus, democratic current sharing scheme is employed to achieve current sharing between units. Connector JCS on the secondary side control card is provided to connect current sharing bus between units. O-ring diodes are recommended when units need to operate in parallel mode. Remote sensing of the output voltage shall be done at the cathode side of the o-ring diodes.

The minimum loading requirements for each individual power supply still apply.

Output Voltage Regulation and Remote Sensing
The total output regulation including both line and load variations shall be +2% for the main outputs and +5% for the auxiliary outputs at input voltages >90VAC provided that minimum load condition is satisfied.

The NLP150L power supplies provide remote sensing for both the first and the second outputs. The remote sense circuitry can overcome up to 0.4V voltage drop along the load cable.

When remote sense is implemented, the output voltage regulation accuracy will be maintained at point of sensing. Otherwise, the output voltage regulation specification will be maintained at the remote sense connector, JRM3 and JRM5, which are on the secondary side control card. Additional voltage drop may be caused by the output cables in the latter, which in turn causes degraded output regulations at the load.

When remote sense is used, the total output power shall be limited to rated full power measured at output terminals of the power supply.

Output Ripple and Noise

The peak-to-peak ripple and noise for all outputs shall be less than 1%* of the nominal output voltages or 50mV, whichever is more, measured 6" from output connector along the output cable (wiring) with a 20MHz bandwidth. A 10µF electrolytic capacitor and a 0.1µF ceramic capacitor are used across the test points during the measurement. The ripple and noises are measured at 60Hz input with North American line (90VAC - 132VAC) or 50Hz input with European line (180VAC - 264VAC). Please refer to Table 14 for the specification and Figure 6 for the test setup illustration.

Model	Output Voltage Ripple and Noise					
NLP150L-96S3	3.3V	50mV				
NLP150L-96S5	5.1V	50mV				
NLP150L-96T658	12V	120mV	5.1V	50mV	+24V	240mV

Table 14 - Output Voltage Ripple and Noise

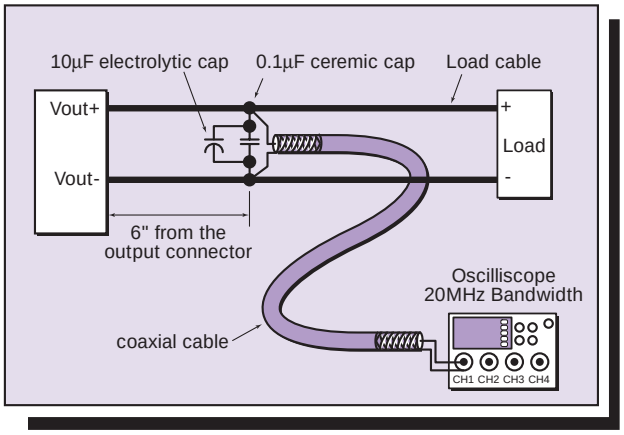

Figure 6 - Illustration of the Setup for Ripple and Noise Measurement

Transient Response

The transient response for the main outputs shall be less than 5% with less than 1mS recovering time when a 25% step load change from 75% rated current with a slew rate of 0.1A/us is introduced.

Hold-up Time

The main outputs shall maintain within its regulation range for a period of 20ms minimum at 120VAC input, maximum rated load following a loss in AC line power. The AC line power is programmed to disappear at the zero crossing during the hold-up time test and the hold-up time is measured from the zero-crossing point where the AC line disappears to the point the main output voltage goes out of its regulation range.

* The ripple/noise spec is for 25ºC ambient only.

Alarm/Power Fail

The NLP150L power supplies provide AC power fail detection. The signal is given out at J6 on the main board. Under normal status, the output of J6 is a steady 5.1V and it doesn't have source capability. When power fail is triggered, a low signal is given out and the sink capability is 50mA. The signal is given out at least 5ms before main outputs (V_A and V_B) fall out of regulation.

5. EMI

Conducted Emissions

The NLP150L power supplies have internal EMI filters to ensure the converters' conducted EMI levels comply with EN55022 FCC Part 15 Class B and EN55022 CISPR 22 Class B limits. The EMI measurements are performed with resistive loads under forced air convection at maximum rated loading with the power supply sitting on a metal chassis. The dimension of the metal chassis exceeds at least 0.25" beyond the edge of the power supply in all four directions. Standoff of 0.25" is used between the power supply and the chassis. If measured in open-frame, shielded input cable is recommended. Figure 7 is an illustration of the setup.

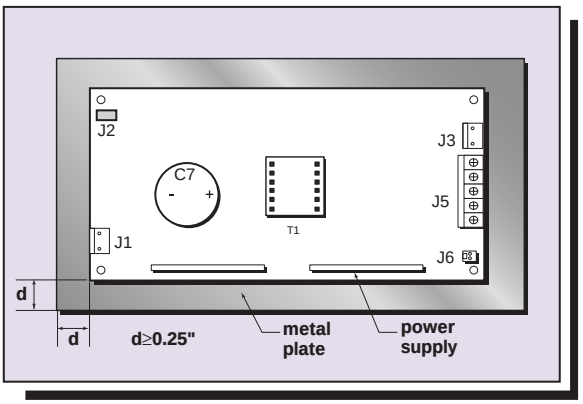

Figure 7 - Conducted EMI Measurement Setup

Radiated Emissions

Unlike conducted EMI, radiated EMI performance in a system environment may differ drastically from that in a stand-alone power supply. The shielding effect provided by the system enclosure may bring the EMI level from Class A to Class B. It is thus recommended that radiated EMI be evaluated in a system environment.

The target of radiated EMI performance measured stand-alone is class A of EN55022 and FCC Part 15. To meet the target, the unit may require a line choke formed using a ferrite core with three (3) turns of all three input wires place between the AC inlet and the input connector. Recommended cores are Mag. Inc. J42212TC, Phillips 846T5003E2A, or equivalent. Figure 8 is the illustration of the setup.

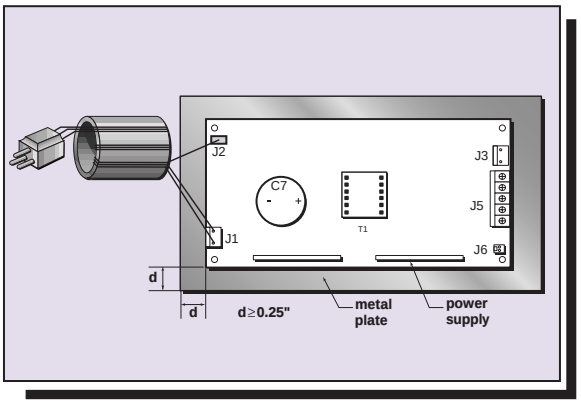

Figure 8 - Stand-alone Radiated EMI Measurement Illustration